

### **REMARKS**

Applicants amend claims 1, 9, 10 and 11 as set forth above. Claims 3 and 4 have been canceled. No new claims have been added. Upon entry of this amendment, claims 1-3 and 9-11 are presented for examination. For the reasons that follow, Applicants respectfully submit that claims 1-3 and 9-11 define over the art of record.

#### **Interview Summary**

Applicants thank the Examiner for the telephone interview between Applicants' representatives, Danielle Herritt and Anita Bowles, and Examiner George Wyszomierski conducted on September 14, 2007. In the interview the Examiner reviewed Applicants' proposed amended claims. The Examiner also indicated that submission of a declaration with evidence that the  $\gamma$ -phase area ratio of the alloy described the Oikawa APL reference falls outside the range specified in claim 1 may overcome the obviousness rejection with respect to the Oikawa APL reference. Applicant's representatives also explained the Applicants' position that the claimed limitation of "at least 40% by area of crystal grain boundaries of said  $\beta$ -phase being occupied by said  $\gamma$ -phase" is not obvious in view of the Oikawa APL reference and the JP'273 reference.

#### **Amendments to the Claims**

Claim 1 has been amended to incorporate the limitation "*the fraction of said  $\gamma$ -phase volume in said shape memory alloy being 5 to 50% by volume,*" which previously appeared in claims 3 and 4. Accordingly, claims 3 and 4 have been canceled. Claim 1 has also been amended to incorporate the limitation "*wherein said alloy has a tensile strength of about 400-1100 MPa,*" support for which appears at least on page 21 of the specification. Claim 1 has further been amended to incorporate the limitation of "*a shape recovery of 18% or more,*" support for which appears at least on page 21 of the specification.

In Claims 9 and 10 the phrase "*at least 40% by area of crystal grain boundaries comprises,*" has been amended to recite "*at least 40% by area of crystal grain boundaries is created by,*" to address a rejection under 35 U.S.C 112 second paragraph. In claim 11, the word

“heating” has been inserted into the phrase “heat treatment step comprises heating at 1350°C for 0.5 hours” to correct an inadvertent omission.

No new matter has been added in the aforementioned claim amendments

Claim Rejection under 35 U.S.C. § 112, second paragraph

Claims 9-11 stand rejected under 35 U.S.C. 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. With the submission of the aforementioned amendments to the claims, Applicants respectfully submit that all pending claims particularly point out and distinctly claim the subject matter which Applicants believe to be the claimed invention.

The Examiner stated, “It is unclear how an ‘area’ can comprise a heat treatment.” As described above, Applicants amended claims 9 and 10 to recite “at least 40% by area of crystal grain boundaries is created by a . . . heat treatment.” Applicants respectfully submit that the aforementioned amendments of the claims address all of the above rejections and request reconsideration and withdrawal of this rejection.

Claimed Invention

The pending claims are generally directed to a shape memory alloy that has excellent mechanical strength and shape recovery ratio. The alloy contains 23 to 27 atomic % of Al and 39 to 45 atomic % of Co, the balance being 28 to 38 atomic % of Ni and inevitable impurities. The alloy has a two-phase structure comprising a  $\beta$ -phase having a B2 structure and a  $\gamma$ -phase having an fcc structure with the fraction of said  $\gamma$ -phase volume in the shape memory alloy being 5 to 50% by volume. In the alloy at least 40% by area of crystal grain boundaries of the  $\beta$ -phase are occupied by the  $\gamma$ -phase, which is referred to as a  $\gamma$ -phase area ratio of at least 40%. The high  $\gamma$ -phase area ratio structure correlates with a desirable combination of a high tensile strength of about 400 to about 1100MPa and a high shape recovery ratio of about 18% or more.

Claim Rejections under 35 U.S.C. § 103(a)

Claims 1-4 and 9-11 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over the Applied Physics Letters article “Promising Ferromagnetic Ni-Co-Al Shape Memory Alloy System,” (K. Oikawa *et al.*, Applied Physics Letters **79**, 3290-3292) (hereinafter the Oikawa APL reference) or over the abstract of the Japanese patent application publication number JP 2002-129273 (hereinafter the JP’273 reference). Applicants amend independent claim 1, cancel claims 3 and 4, and submit the following remarks in support of the patentability of claims 1-2 and 9-11.

The Oikawa APL Reference

The Examiner acknowledges that the Oikawa APL reference does not specify the  $\gamma$ -phase area ratio in of the alloys discussed; however, the Examiner asserts that it is a reasonable assumption that the crystal structures of the prior art are substantially the same as those of the present invention. The Examiner bases this assumption on the assertions that the prior art compositions are substantially the same as those claimed and that the prior art alloys appear to be made by substantially similar processes as those of the present invention. Applicants respectfully submit that the assumption that the alloy of the Oikawa APL reference has the same crystal structure as the claimed alloys is false and provide both evidence and arguments to show that the crystal structure of the claimed alloy is different than the crystal structure of the alloys of the Oikawa APL reference.

In support of the Applicants’ position, Applicants submit herewith two different declarations under 37 CFR §1.132 executed by Professor Katsunari Oikawa, an inventor of the pending application and an author of the Oikawa APL reference, that establish that the alloy of the Oikawa APL reference does not have a structure in which “*at least 40% by area of crystal grain boundaries of the  $\beta$ -phase are occupied by the  $\gamma$ -phase,*” as required by amended independent claim 1. The two declarations were executed on different dates, one on October 9, 2007 and one on September 27, 2007. The Oct. 9<sup>th</sup> declaration presents unpublished experimentally determined values of the  $\gamma$ -phase area ratio and the tensile strength of an alloy (alloy “G” or comparative example 2) described in the Oikawa APL reference. The Oct. 9<sup>th</sup> declaration also contains Prof. Oikawa’s opinion that the claimed shape memory alloy would not be obvious in light of the Oikawa APL reference and the JP’273 reference. The Sept. 27 declaration, which is referred to as ‘Exhibit A’ within the Oct. 9<sup>th</sup> declaration, details Prof. Oikawa’s experience and expertise in the field of Materials Science and provides details of the

experiments conducted by Prof. Oikawa which determined the values of the  $\gamma$ -phase area ratio and the tensile strength of alloy “G” (comparative example 2).

The Examiner cites the first full paragraph of page 3292 of the Oikawa APL reference as describing an example alloy that meets the compositional limitations of claim 1 and that contains 7%  $\gamma$ -phase by volume. Within the Oikawa APL reference, this example is called alloy “G”. The Oct. 9<sup>th</sup> declaration states that the experimentally determined  $\gamma$ -phase area ratio for alloy “G” (comparative example 2) is 32% (number 5, pages 2 and 3). As stated on page 4 of the Oct. 9<sup>th</sup> declaration, the  $\gamma$ -phase area ratio is very sensitive to heat treatment. Differences between the heat treatment of alloy “G” (comparative example 2) of the Oikawa APL reference and the heat treatment disclosed in the present application create different  $\gamma$ -phase area ratios. The Oikawa reference has no teaching or suggestion regarding a relationship between heat treatment and the  $\gamma$ -phase area ratio. The Oikawa APL reference is silent regarding the  $\gamma$ -phase area ratio of shape memory alloys, and the particular alloy cited by the Examiner in the Oikawa APL reference does not have a  $\gamma$ -phase area ratio of at least 40% as required by claim 1. Thus, the limitation of “*at least 40% by area of crystal grain boundaries of said  $\beta$ -phase being occupied by said  $\gamma$ -phase,*” as recited by amended independent claim 1, is not obvious in light of the Oikawa APL reference.

Alloys with the required compositional and structural limitations exhibit an unexpected and desirable combination of high tensile strength and high shape recovery ratio. As recited in claim 1, the claimed alloys have a tensile strength of about 400 to about 1100MPa and a shape recovery ratio of about 40% or more. On pages 2 and 3 of the Oct. 9<sup>th</sup> declaration, Prof. Oikawa states that the comparative example 2 alloy (example G) described in the Oikawa APL reference has a shape recovery ratio of 83% and a tensile strength of 260 MPa. The comparative example 2 alloy of the Oikawa APL reference does not exhibit both a shape recovery ratio of at least 18% and a tensile strength of between about 400MPa and about 1100MPa as required by amended independent claim 1. As stated on the bottom of page 3, “The Oikawa APL article does not teach or suggest a correlation between a  $\gamma$ -phase area ratio of over 40% and the desirable combination of high tensile strength and a high shape recovery ratio.” The Oikawa APL reference fails to disclose, teach or suggest a shape memory alloy with both a shape recovery ratio of at least about 18% and a tensile strength of between about 400MPa and about 1100MPa as required by amended independent claim 1.

The JPL '273 Reference

The Examiner states that the English Abstract of JP '273 "discloses compositional ranges that fully encompass those as presently claimed." The Examiner concedes that the English Abstract of JP '273 does not disclose the percentage area of grain boundaries occupied by gamma phase, and does not specify the overall amount by volume of gamma phase in the described alloys; however, the Examiner states that it is a reasonable assumption that the crystal structures of the alloys in the JP '273 reference are substantially the same as those of the present invention. Applicants provide both evidence and arguments to establish that compositions of the alloys in the JP '273 reference do not fall within compositional range of claim 1, and further that the crystal structures of the alloys in the JP '273 reference are different than those of the alloy of claim 1.

Although the English Abstract of JP '273 mentions alloys that fall in a broad compositional range of 5 to 70 atomic % Co, 5 to 70 atomic % Ni, and 5 to 50 atomic % Al, the sample alloys presented in the JP '273 reference do not have compositions near the range of compositions recited by the current claims. None of the sample alloys presented in the table on page 7 of the JP'273 reference has a composition in the range of 23 to 27 atomic % Al. Of the samples presented in the table on page 7 of the JP '273 reference, one sample has 9 atomic % Al and the other samples have between 38 and 61 atomic % Al, as described on page 4 of the Oct. 9<sup>th</sup> declaration (these numbers were converted from the mass % of the table into atomic %). The compositions of the samples whose properties are described in the JP'273 reference all fall far from the claimed range of 23 to 27% atomic % Al.

As established by the data concerning comparative example 2 of the Oikawa APL reference, details of thermal processing can greatly affect microstructure, such as the  $\gamma$ -phase area ratio. It is unreasonable to assume that an alloy with a composition far from the composition recited in the claims and whose thermal processing is unknown will have a crystalline structure with the fraction of the  $\gamma$ -phase volume in the shape memory alloy being 5 to 50% by volume, with at least 40% by area of crystal grain boundaries of the  $\beta$ -phase being occupied by the  $\gamma$ -phase, and to further assume that the alloy has a tensile strength of 400-1100MPa and a shape recovery of 18% or more, as required by amended independent claim 1.

The Oikawa APL reference and the JP'273 reference, alone or in combination, do not disclose, teach or suggest a shape memory alloy with "*at least 40% by area of crystal grain boundaries of said  $\beta$ -phase being occupied by said  $\gamma$ -phase*" that has "*a tensile strength of about*

*400-1100 MPa and a shape recovery of 18% or more,”* as required by amended independent claim 1. Moreover, Professor Oikawa states in the declaration that the shape memory alloys described in the claims of the present application are “unobvious in view of the Oikawa APL reference and in view of the JP’ 273 reference,” (Oct. 9<sup>th</sup> declaration, no. 6, page 4). Professor Oikawa also states that “Alloys of the proposed amended claims exhibit an unexpected and surprising combination of high shape recovery ratio and high tensile strength compared to the alloys described in the Oikawa APL reference,” (Oct. 9<sup>th</sup> declaration, no. 6, pages 3-4). Accordingly, Applicants respectfully request reconsideration and withdrawal of this rejection of amended independent claim 1.

Claims 2-3 and 9-11 depend, either directly or indirectly from amended independent claim 1. As such, claims 2-3 and 9-11 incorporate the allowable subject matter of amended independent claim 1, as well as reciting their own patentable subject matter. Accordingly, Applicants respectfully request reconsideration and withdrawal of this rejection of claims 2-3 and 9-11.

**CONCLUSION**

In view of the above arguments, the amendments and the declarations, Applicants respectfully submit that the Oikawa APL reference and the JPL'273 reference fail to disclose, teach or suggest each and every element of claims 1-3 and 9-11. Additionally, Applicants respectfully submit that the subject matter of claims 1-3 and 9-11 would not have been obvious to one skilled in the art in view of the Oikawa APL reference and the JPL'273 reference. Accordingly, Applicants respectfully urge the Examiner to reconsider and to withdraw the current rejections and pass the claims into allowance. Should there be any outstanding issues of patentability following the entry of this response, a telephone interview is respectfully requested to resolve such issues.

Applicants believe no fee is due with this statement. However, if a fee is due, please charge our Deposit Account No. 12-0080 under order No. TAW-008RCE from which the undersigned is authorized to draw.

Dated: October 12, 2007

Respectfully submitted,

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